Digital Counter

In this project, you will make a 3-bit digital counter, and display the count using a 7-segment display. The particular counter in this project is a *ripple counter*, named because changes propagate ("ripple") through the system, rather than happen all at once. This type of counter is simpler than a *sequential counter*, where all updates happen at once (synchronously). The disadvantage of the ripple counter is that the output can fluctuate wildly at certain transitions, making it a poor choice if the outputs are used as inputs to other digital circuits that expect a specific sequence of inputs. Since the output of this system is a display for humans, whose eyes are too slow to see the ripples, this counter is adequate for this project. If you would like to see the ripples, then try hooking up the outputs to an oscilloscope.

Equipment

- Cadet Board
- 7473 Dual JK Flip-Flop DIP (x2)
- 7447 BCD to 7-Segment Display Decoder
- MAN72 7-segment display
- 100 Ohm resistor (x2)
- wires

Procedure

On the Cadet board, make sure to turn off the power before building your circuit. You will be using the logic switches on the bottom and the LED logic indicators on the right. Make sure these are both set to 5V with the control switches, and that the logic indicators are set to TTL. If you set these incorrectly, the logic high indicators (green LEDs) will not light up. The Cadet has a built in TTL clock, on the left side. The clock's voltage is set for TTL logic, so the only parameter that is adjustable is the frequency. You should set it to a low frequency, such as 1 Hz. Set the switches to Hz and 1 or 10.

The logic family used by the components in this project is TTL (Transistor-Transistor Logic). All TTL components have a +5V supply (usually denoted V_{CC}) and a ground connection. The naming scheme for TTL chips is somewhat complicated. The "74" refers to the range of temperatures the device is designed to operate in. The other two or three numbers denote the device's function. There are usually a few letters between the temperature number and the function number, which indicates what "flavor" of TTL logic is used. Other numbers and letters indicate manufacturer, variations, etc. Many TTL components are DIPs (Dual Inline Packages). On most DIPs, there is a dot marking the first pin, and a semicircle marking the top (pin 1 is at the top left corner).

On the 7447, ground is pin 8 and V_{CC} is pin 16. On the 7473, ground is 11 and V_{CC} is 4. The MAN72 is not a logic device, it's simply a collection of LEDs. LEDs have two terminals, called *anode* and *cathode*. In the MAN72, the anodes are tied together at pins 3 and 14. Connect the anodes to +5V with the two resistors. Make sure that the resistors are in parallel, i.e. one resistor per anode and each resistor connected to +5V.

Connect the MAN72 to the 7447 and test the circuit with the logic switches. Don't do anything with the lamp test, blank in, and blank out pins, they are not necessary for this project. You should be able to display the digits 0-9 on the MAN72 by changing the binary inputs ($b_3b_2b_1b_0$) (see the table for binary to decimal conversion).

Use the flip-flop diagram and the diagram of the 7473 to make the counter. Remember that V_{CC} is the same as logic 1. Check the outputs ($b_2b_1b_0$) with the logic indicators. They should count to 7 in binary (see the table). The clr (clear) pin of the flip flops should be logic 1 (the circle means invert, therefor “don't clear”).

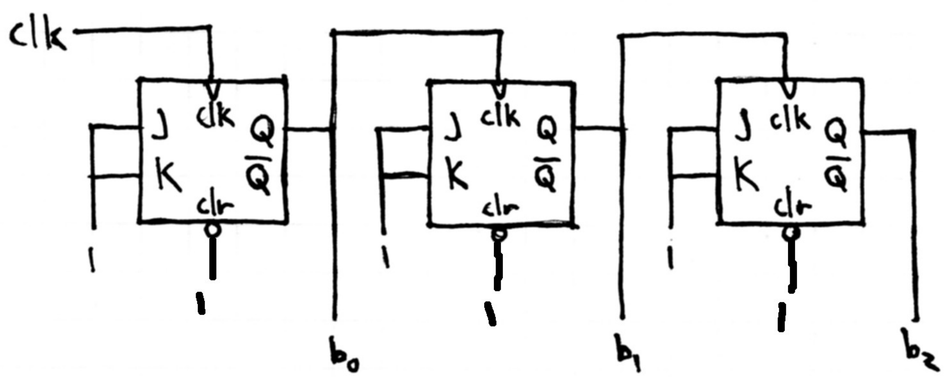
When you have tested the two parts of the circuit, connect the outputs of the counter to the corresponding inputs of the 7447. Connect the b_3 input on the 7447 to ground, because that bit should always be zero.

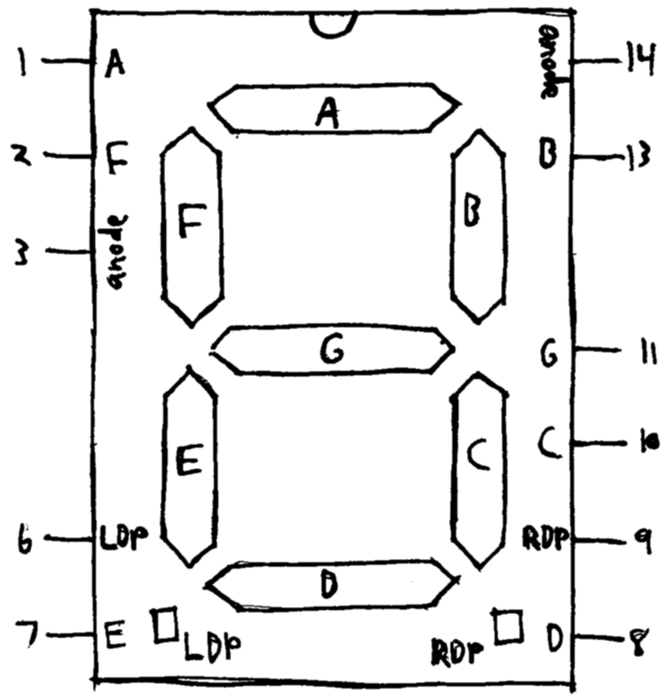
When you have your implementation tested and checked off, put everything away in the correct bins and leave the lab better than you found it.

Further Reading

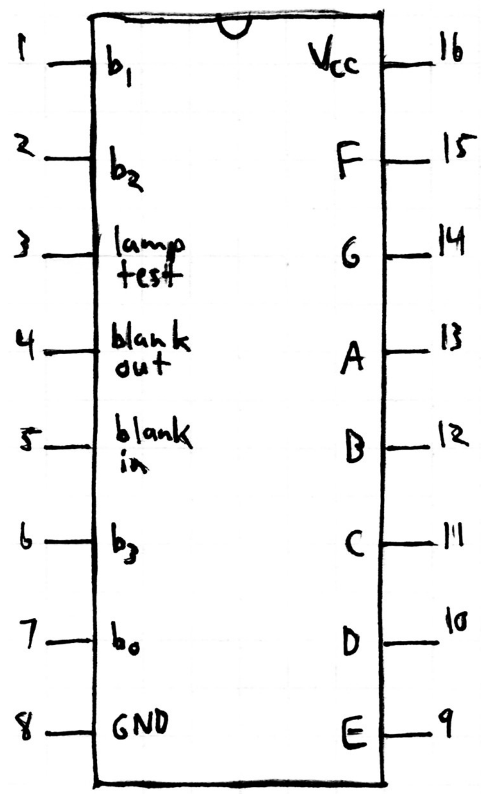
- http://www.play-hookey.com/digital/jk_nand_flip-flop.html
  - This shows how to make a JK flip-flop with NAND gates. Elsewhere on the site are pages about sequential and ripple counters.

Binary	*Decimal*	*Binary*	*Decimal*
0000	0	1000	8
0001	1	1001	9
0010	2	1010	10
0011	3	1011	11
0100	4	1100	12
0101	5	1101	13
0110	6	1110	14
0111	7	1111	15

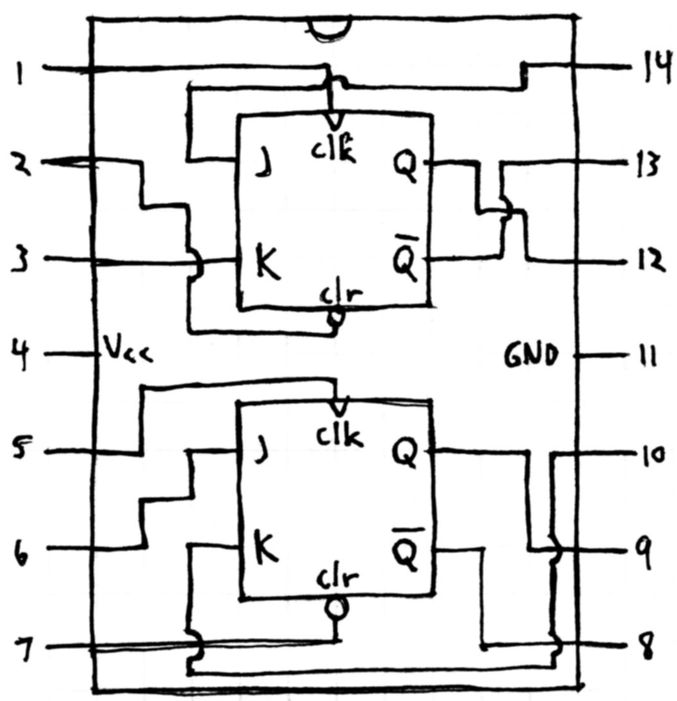




MAN72



7447



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